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WOODS HOLE OCEANOGRAPHIC INSTITUTION

Reference No. 64-28

Sweep Synchronized Positionable Trigger and
Supplementary Components

WOODS HOLE, MASSACHUSETTS

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts

Reference No. 64-28

Sweep-Synchronized Positionable Trigger and Supplementary Components

by

W. E. Witzell

Submitted to the Office of Naval Research under
Contract Nonr-4029(00)

May 1964

APPROVED FOR DISTRIBUTION Richard H. Backus
R. H. Backus,
Deputy Chairman
Department of Geophysic

ABSTRACT

This report describes the Sweep-Synchronized Positionable Trigger, together with its functions and supplementary components, as designed and built for use with the Precision Graphic Recorder (PGR) at the Woods Hole Oceanographic Institution. The positionable trigger provides a means for plotting a variable on the PGR record as a function of time, for triggering equipment such as oscilloscopes at any time, for displaying ship's heading, and for supplying, semi-automatically, ocean depth to a ship-board computer.

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INTRODUCTION

During the development of the Precision Graphic Recorder (Knott and Witzell, 1960) as an echo-sounder recorder, various electro-mechanical devices have been built to augment its usefulness as a readout and programmer for other oceanographic equipment. The Sweep-Synchronized Positionable Trigger (Figs. 1 and 2) has been designed to give the PGR operator a means of plotting some variable as a function of time or displacement along the sweep and to trigger other equipment at any time.

Our initial objective was to build a course recorder, so that time, depth, and ship's heading could be recorded concurrently on a single record. While linking the reed switch and magnet assembly to a gyro repeater (Fig. 3) for course recording, it became obvious that positioning of the closure of the switch could be done manually as well as by the gyro repeater, thus making an ideal variable-position trigger for external units. The device has since been adapted to the triggering of oscilloscopes, relays, and cameras, and also has been used as part of a semi-automatic ocean-depth input to a ship-board computer. The frame of the trigger unit is designed to accept additional servomount devices such as sweep-generator components for the synchronization of an oscilloscope to the PGR sweep.

DESIGN

The heart of the contrivance is a differentially controlled contact made by a magnetic reed switch. The differential action is required to enable the trigger position to be adjusted to any position in the sweep cycle. Visual reference of the trigger position on the recording can be made with the use of circuitry existing in the PGR. The trigger contact closure time can be recorded either as a short pulse or actual contact closure time.

One of the primary considerations was to avoid loading the PGR mechanical drive to the extent that the synchronization of the recorder to its time base would be disturbed. The utilization of a magnet and magnetic reed switch, which do not come in physical contact with one another, results in a very small transient load to the drive. The trigger unit is assembled around the axis of the shaft which rotates the helix of the PGR. (Figs. 4 and 5)

The magnet, which is held in a circular holder, is fixed to the helix shaft and rotates with the shaft within a formica cylinder fastened to a non-magnetic spur gear. The reed switch is wired to slip rings, and is assembled in the cylinder. The spur gear rotates on a bearing centered around the shaft extension of the PGR. The bearing has a bore large enough to clear the helix shaft extension. The bearing allows the gear to turn freely within its own housing without coming in contact with the shaft extension.

To position the reed switch, the spur gear which holds the reed-switch assembly may be driven by a second spur gear at a 1:1 ratio (#5, Fig. 2), or from a shaft extension through a high-reduction worm-drive. The reed switch thus can be kept in a fixed position or continuously moved in either direction around the same axis on which the magnet is revolving. Manual adjustments are made through a worm-gear reduction via a shaft extension. The shaft holding the second spur gear and the shaft extension of the helix drum are thus available for the mounting of sensing potentiometers or other devices.

The reed switch will close only when the magnet is in the close proximity of the switch. By virtue of being mounted on an extension of the drum shaft, the magnet turns with the recorder helix drum. Therefore, the revolving magnet passes the position of the reed switch and causes a switch closure once during each sweep. The period of time that the switch is closed depends upon the PGR sweep speed, the distance between the magnet and the switch as they pass each other, and the strength of the magnetic field in which the switch contacts pull in or drop out. The initial closure, or pull-in, of the switch is very dependable, but the switch break or drop-out, varies slightly from revolution to revolution. Therefore, the triggering, if it is to be accurate, must be done on switch closure, not on switch opening.

The portion of the sweep during which the reed switch is closed can be recorded on the PGR as a short pulse indicating the closure. When recording the entire period of closure, the input to the recorder is made by connecting the reed switch across the remote marker jack of the PGR (Circuits H30 and H30-A, op. cit.). If a short pulse, coincident with the leading edge of closure is necessary, the reed switch output is inserted in zero-line, or chronometer, input to the scale-line generator of the PGR (Circuit H-20, op. cit.).

APPLICATIONS

Course Recording

Ship's heading can be recorded continuously together with other data by driving the magnetic reed switch with a gyro repeater, selsyn, or step-by-step motor and connecting the switch to the zero-pulse input of the PGR scale-line generator. Ship's heading will be recorded as a line on the recording paper, which, when calibrated, indicates 0° to 360° from margin to margin. The recorded line will move back and forth across the paper as the ship's heading changes. (Fig. 6)

Since there are 360° in the helix sweep of the recorder, the operator merely adjusts the gyro-repeater and the position of the reed switch to cause closure at the correct position relative to the margins of the recording paper. One chooses which point of the compass is to be represented by the margins. As the ship's heading changes, the gyro repeater moves the position of the reed switch and changes the position of recorded dots. If the margins are chosen to be north, one quarter of the way across the sweep would be 90°, or east; halfway, 180°, or south; and three-quarters, 270°, or west. Sweep length from margin to margin is defined by the "zero line" of the PGR and heading can be read easily to 1° or even smaller increments. Changes in recording speeds of the PGR only change the rate at which the ship's heading indicator is sampled.

Triggering of Oscilloscopes, Relays and Cameras

By having parallel outputs from a reed-switch closure and by recording this closure on the PGR for visual reference, many kinds of auxiliary equipment can be triggered on a precise schedule. If the reed-switch closure that occurs with each sweep of the PGR helix is fed through a programming system such as the PGR keying-program circuit (see Circuits H30 and H30-A, S. T. Knott and W. E. Witzell, 1960), an even more flexible triggering program (with delays of up to 12 sweeps of the PGR) becomes available (see "Programing-Range Gating", op. cit.).

Trigger positioning and programming may depend upon the following factors: relay delay-time, computer-reading delay-time, oscilloscope sweep periods, shutter and film advance mechanisms of oscilloscope cameras, and character of the recorded signal.

Semi-Automatic Ocean Depth Input to a Shipboard Computer

In this application a 360° precision potentiometer attached to the shaft that is coupled to the reed switch, at a 1:1 ratio, can be used as a voltage divider to indicate the position of the reed switch. The wiper arm of the potentiometer is aligned with the reed switch closure. Voltage division is measured when the reed switch is moved manually so that a pulse is placed at the leading edge of the bottom echo. If the trigger trace is aligned with the trace of bottom echoes, the potentiometer will indicate the position within the sweep (and from this the time within the sweep interval) at which the reflection was observed. The winding of the potentiometer should be as linear as possible and the applied and divided voltage must be compatible with the type of computer input used. To measure echo travel time two factors are needed: one, the output of the potentiometer (which measures the fraction of a sweep) and, two, the number of sweeps after the pulse is initiated. The sweep speed (there is a choice of 12) and the number of sweep intervals between the transmitted pulse and the sweep containing the echo also must be fed separately to the computer. The sweep speed is sensed by means of an additional 12-position deck on the PGR sweep-speed switch. The sweep interval must be determined by the operator and at present is not automatic. It is sensed from switches set by the operator.

ACKNOWLEDGEMENTS

The usefulness and success of an instrument depends upon adequate testing and application under actual field conditions. Mr. Lloyd Breslau's comments and use of the Sweep-Synchronized Positionable Trigger in conjunction with his ocean-bottom reflectivity program are appreciated. Sydney T. Knott and J. B. Hersey proved the success of the course recorder during the search for the lost submarine THRESHER. Their constructive criticism and encouragement have been gratefully received.

The assistance of WHOI machine shop personnel in construction of the units, particularly Mr. Luther V. Slabaugh and Mr. Carlton W. Grant, Sr. is gratefully acknowledged.

This work was carried out under Contract Nonr-4029(00) with the Office of Naval Research.

REFERENCES

Knott, S. T. and W. E. Witzell, 1960. Instruction Manual for Precision Graphic Recorder (PGR). WHOI Ref. No. 60-38.

LIST OF FIGURES

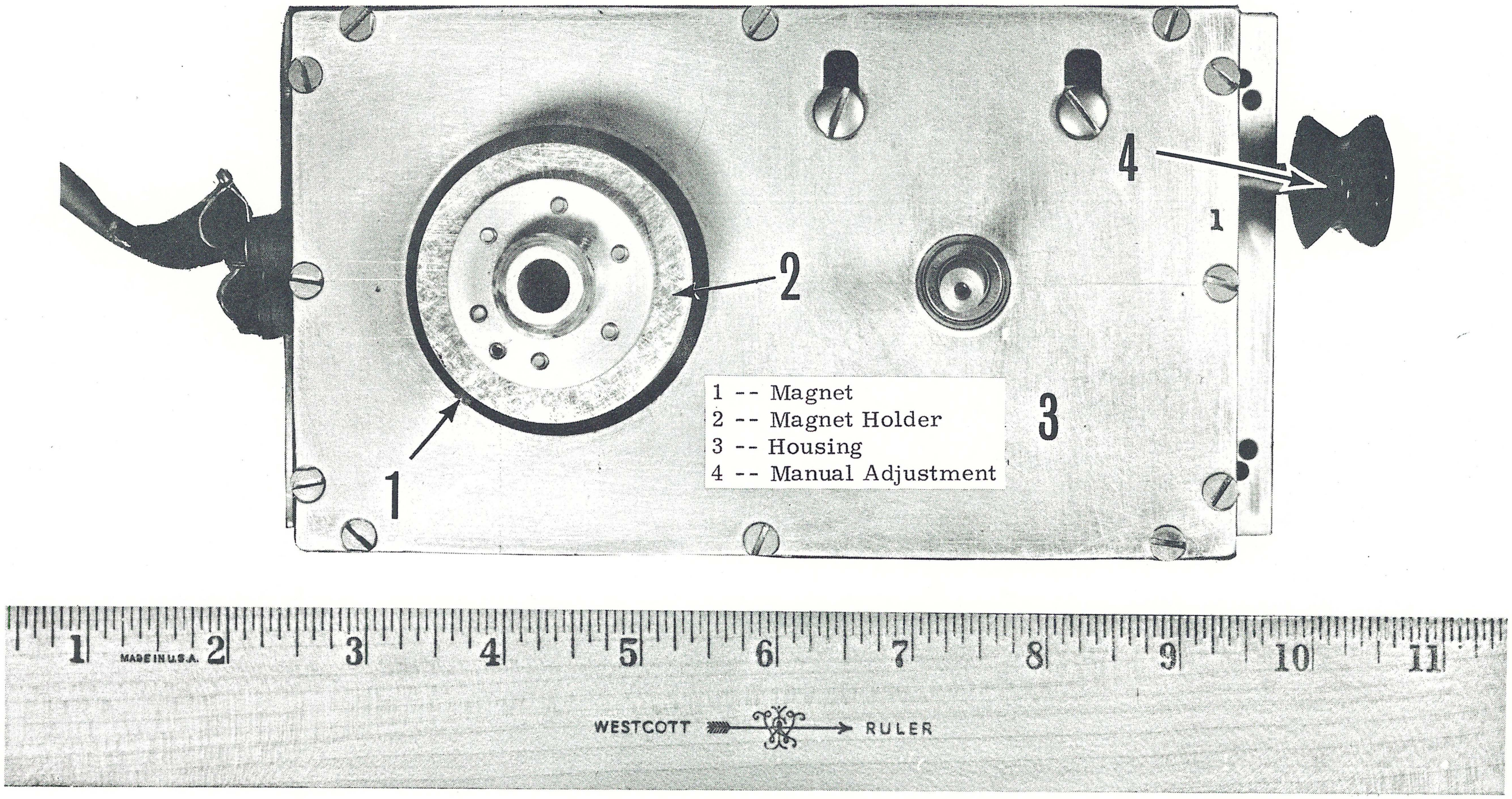


Figure 1 Basic Sweep-Synchronized Positionable Trigger Assembly without Supplementary Components.

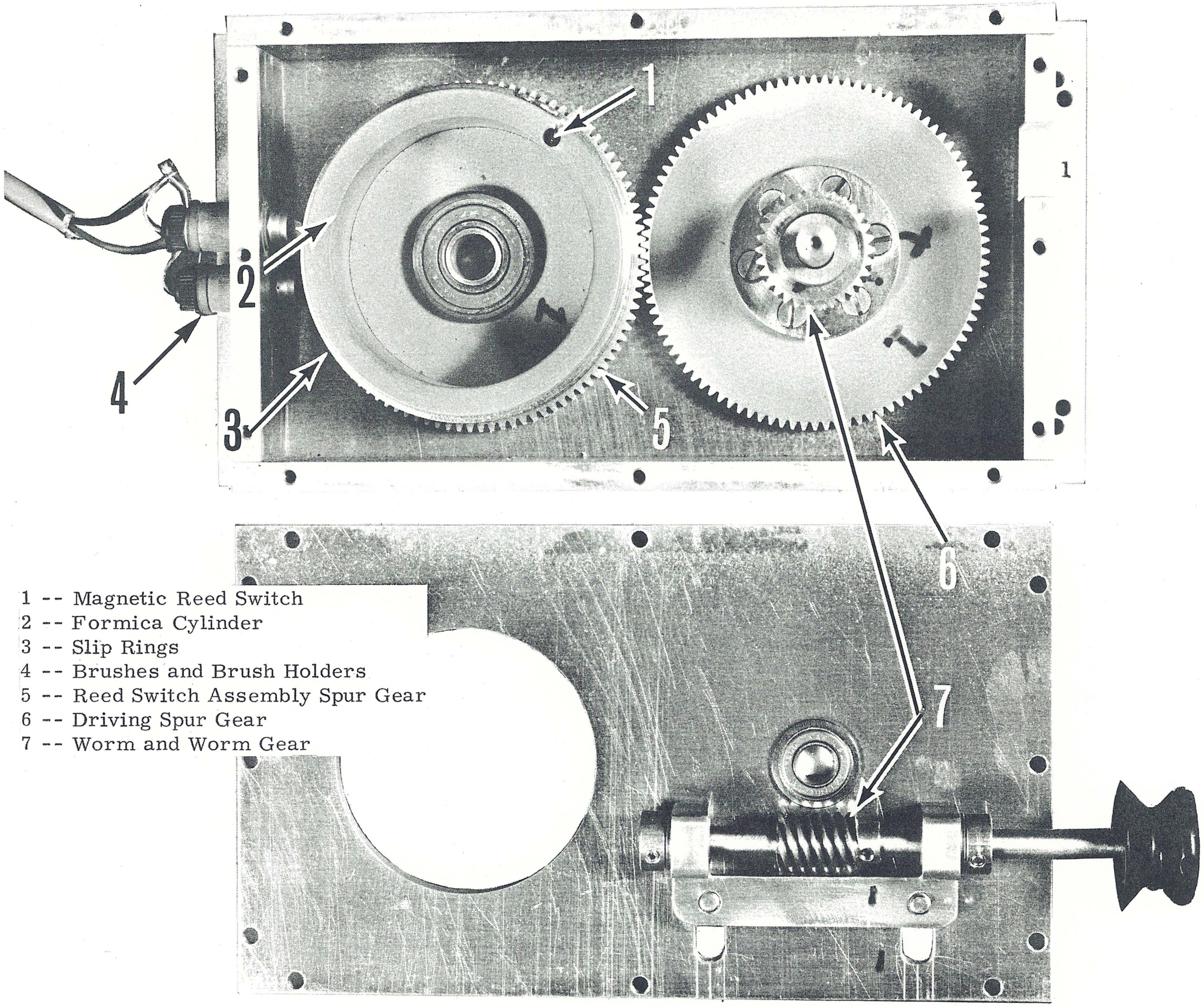


Figure 2 Trigger Assembly with Front Cheek Plate Removed.

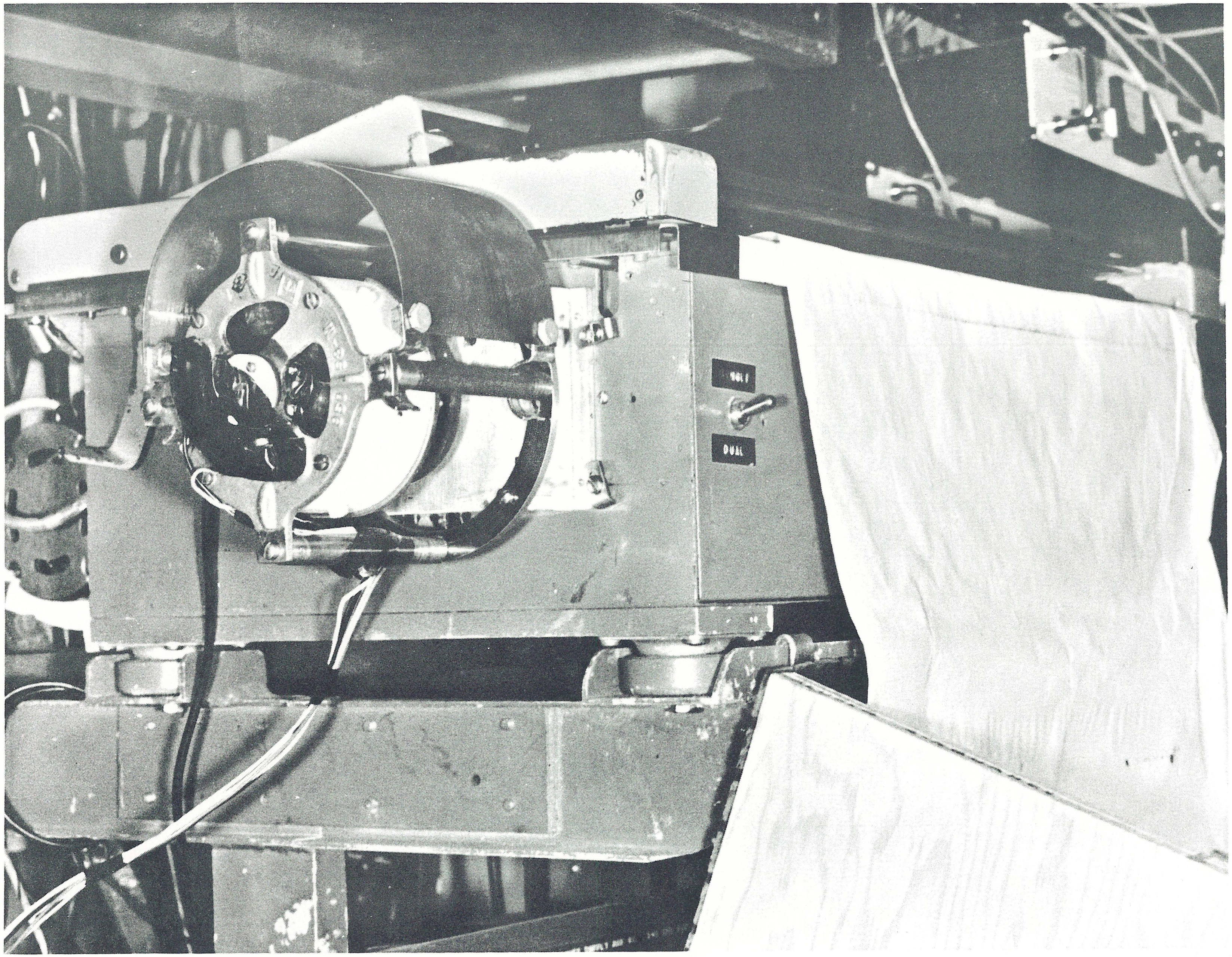


Figure 3 Heading Recording Installation on Precision Graphic Recorder.

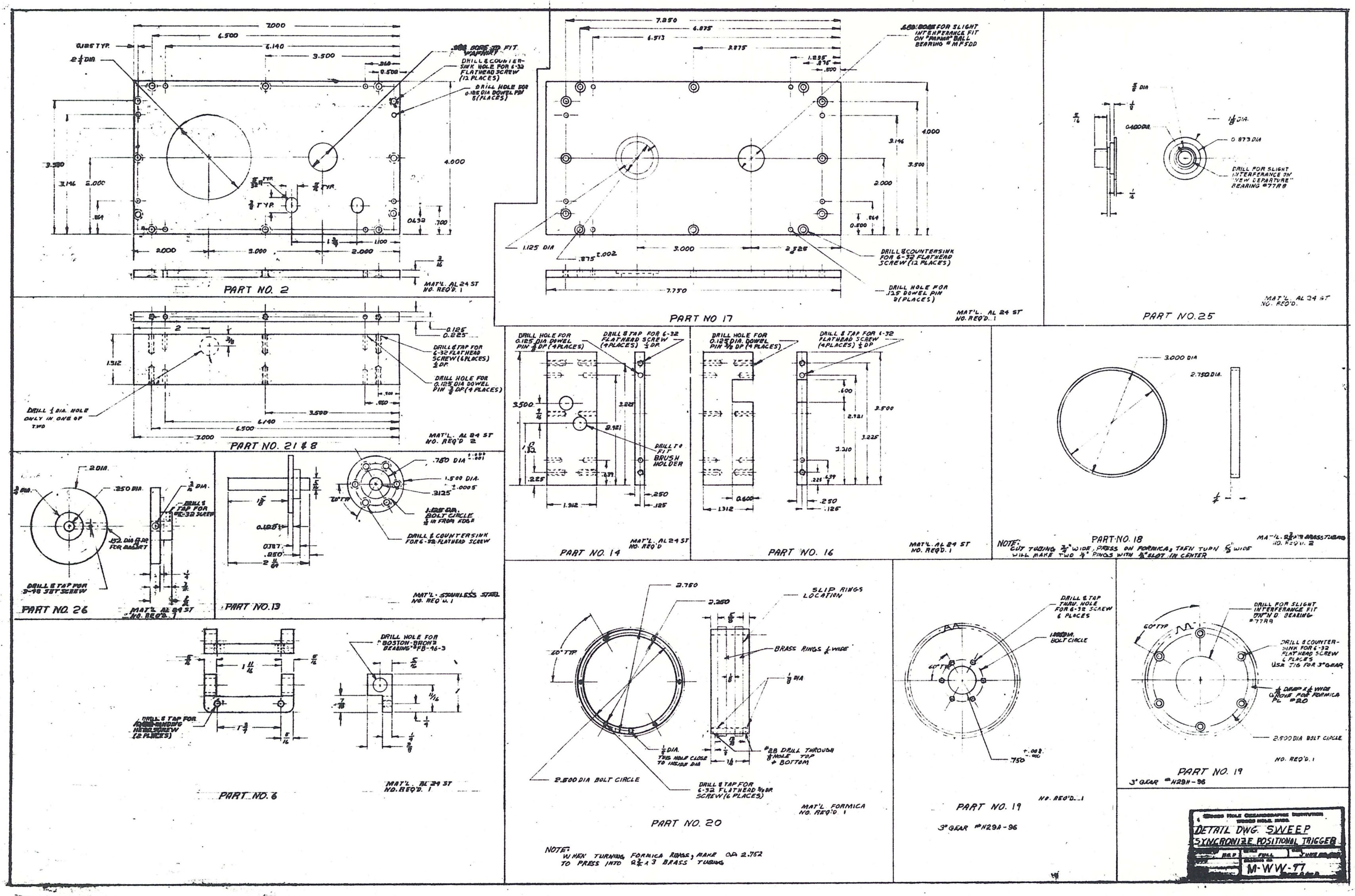
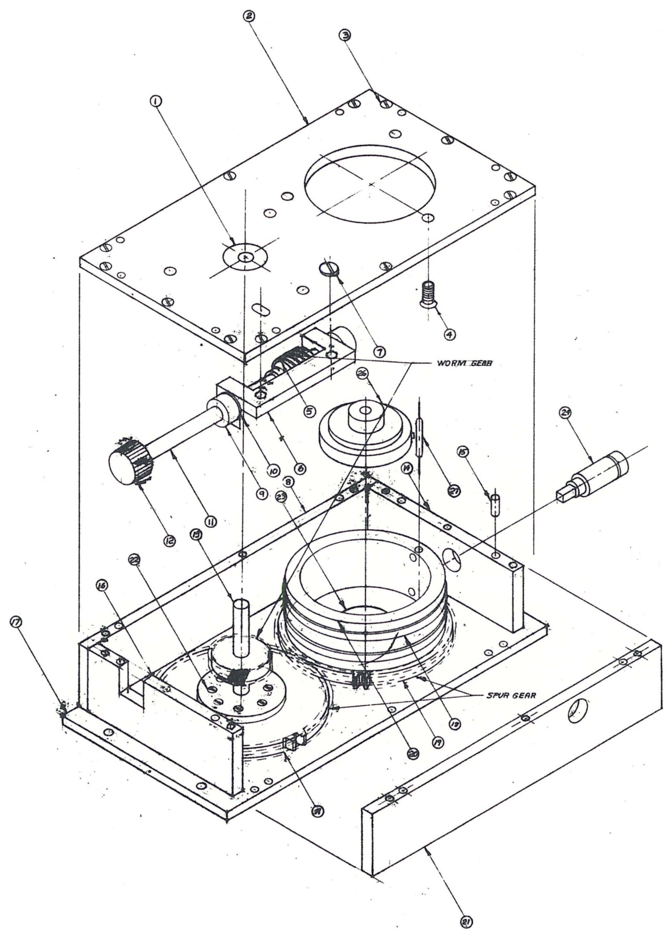


Figure 4 Mechanical Drawing of Gear Box and Components.



PART NO.	NO. REQ.	PARTS LIST DISCRIPTION	MAT'L.
1	2	"FAFNIR" BEARING NO. M F5DD	
2	1	TOP PLATE $\frac{3}{16}$ X 7 X 4	AL 24 ST
3	24	6-32 FLATHEAD SCREWS $\frac{3}{8}$ LG.	
4	6	8-32 FLATHEAD SCREW $\frac{1}{2}$ LG.	
5	1	"BOSTON" WORM GEAR #91327	
6	1	SHAFT HOLDER	AL 24 ST
7	2	10/32 BINDING HEAD SCREW $\frac{1}{2}$ LG.	
8	1	BACK PLATE 7 X 1$\frac{5}{8}$ X $\frac{1}{4}$	AL 24 ST
9	2	THRUST BUSHING	BRASS
10	2	"BOSTON" BRON'Z. BEARING #FB-46-3	
11	1	$\frac{1}{4}$ DIA. SHAFT 5$\frac{1}{4}$ LG	STEEL
12	1	KNOB	PLASTIC
13	1	SHAFT WITH FLANGE	STAINLESS STEEL
14	1	RIGHT SIDE PLATE 3$\frac{1}{2}$ X 1$\frac{5}{8}$ X $\frac{1}{4}$	AL 24 ST
15	16	.125 DIA. X $\frac{1}{2}$ DOWEL PINS	STEEL
16	1	LEFT SIDE PLATE 3$\frac{1}{2}$ X 1$\frac{5}{8}$ X $\frac{1}{4}$	AL 24 ST
17	1	BOTTOM PLATE 7$\frac{1}{2}$ X 4 X $\frac{1}{4}$	AL 24 ST
18	2	BRASS SLIP RINGS	[illegible]
19	2	STERLING PRECISION SPUR GEAR [illegible]	AL 24 ST
20	1	"FORMICA" SLIP RING HOLDER	"FORMICA"
21	1	FRONT PLATE 7 X 1$\frac{5}{8}$ X $\frac{1}{4}$	AL 24 ST
22	6	6-32 X $\frac{1}{2}$ LG FLATHEAD SCREW	STEEL
23	1	"NEW DEPARTURE BEARING" 77R6	
24	2	BRUSH HOLDER	
25	1	BEARING SUPPORT FOR N.D. 77R6	AL 24 ST
26	1	ACTUATION WHEEL	AL 24 ST
27	1	MAGNETIC REED SWITCH "HAMLIN" [illegible]	

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Figure 5 Exploded View of Gear Box Assembly.

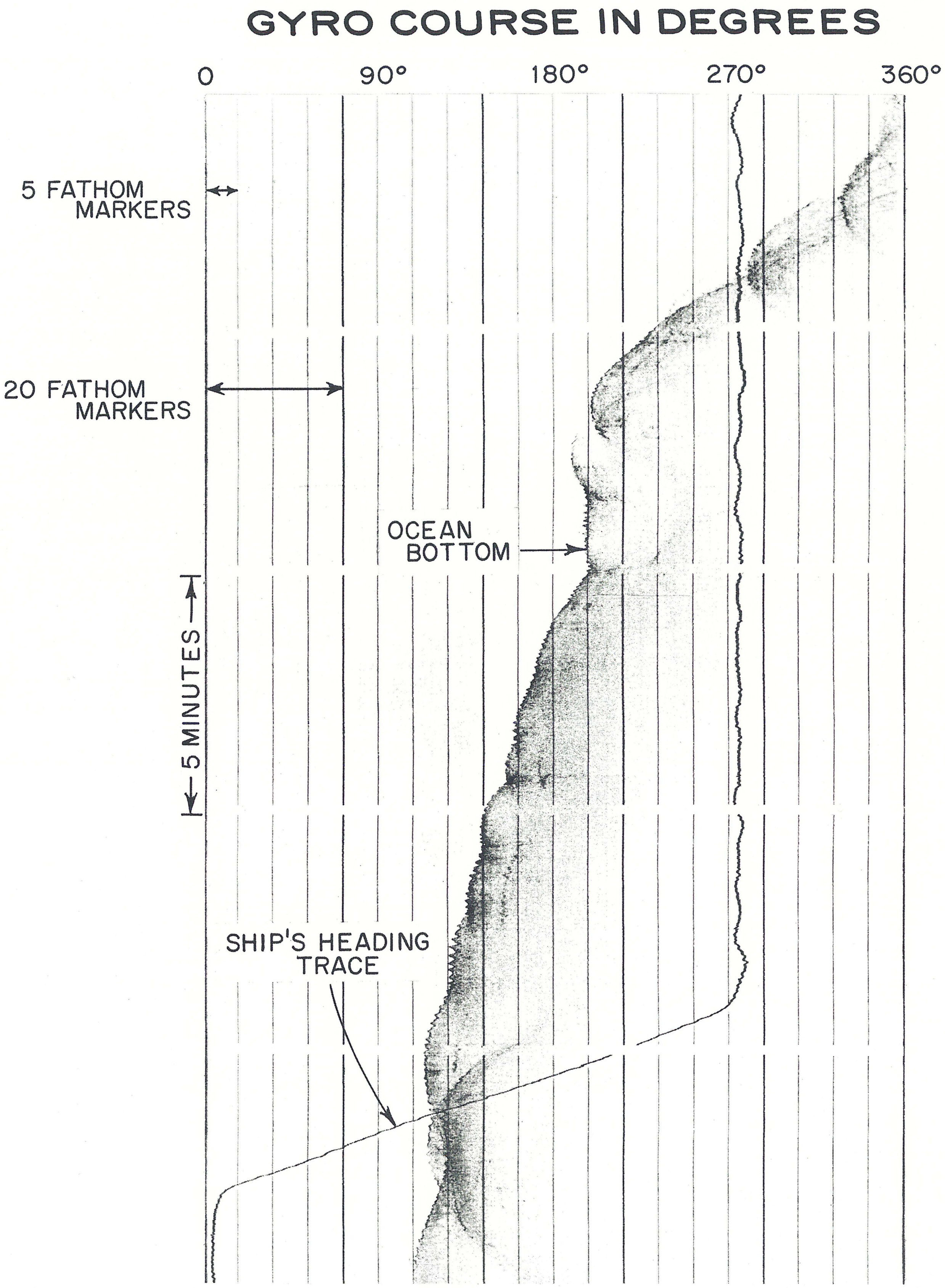

Figure 6 Ocean Depth and Ship's Heading Record.

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2. Course recording
3. Precision Graphic Recorder (PGR)

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